California Air Resources Board

California Environmental Protection Agency

Low Carbon Fuel Standard

Life Cycle Analysis Working Group 1 Meeting

May 9, 2008

Meeting Agenda

- Introductions
- Presentation from University of California, Davis
- Fuel Pathways
  - Methodology of Energy and GHG Emissions Calculations
  - Overview of Completed Pathways and Carbon Intensity (CI) Values
- Discussion
- Future Fuel Pathways
- Other Stakeholder Presentations
- Lunch Break

CA-GREET 1.7 v98

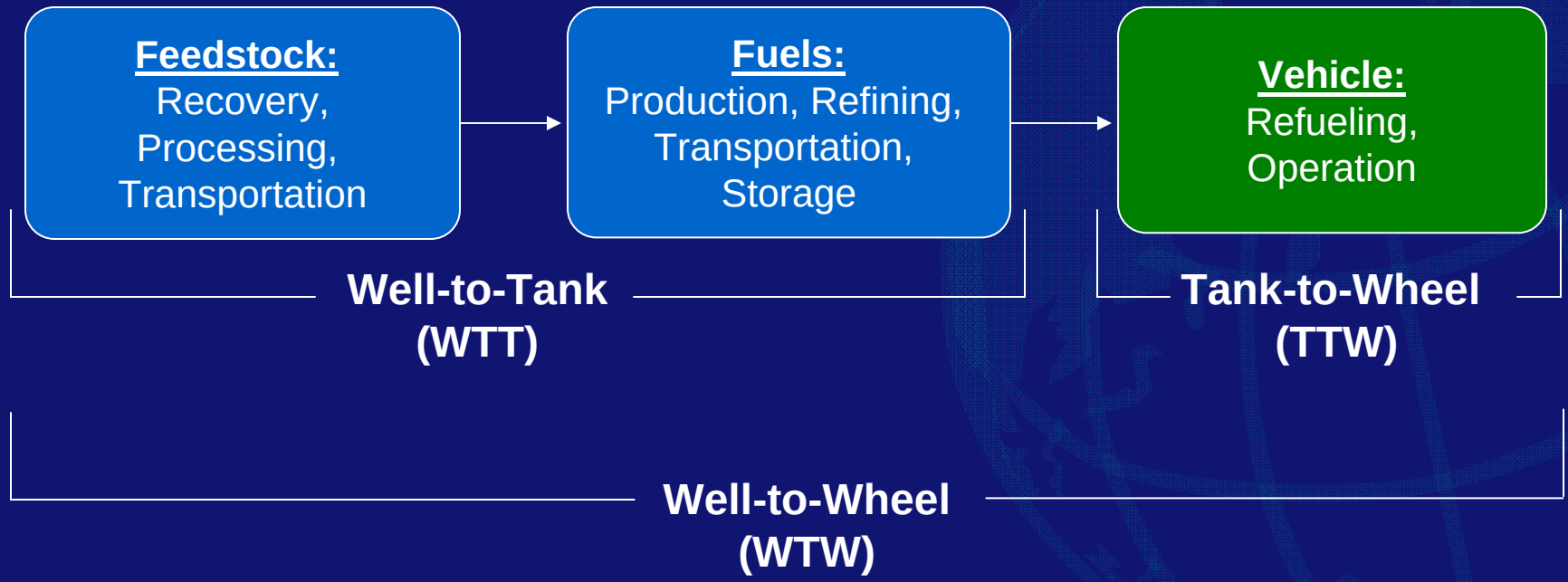
Fuel Pathways
Well-to-Wheel (WTW) Analysis

- ULSD
- CaRFG
  - CARBOB
  - Corn Ethanol
- CNG
- Electricity

CA-GREET 1.7 v98

General Flowchart of Well-to-Wheel Analysis

- **WTT**: Feedstock and fuel production, transportation, and distribution
- **TTW**: Vehicle operation



CA-GREET 1.7 v98

General Notes about the Pathways (1)

- Very specific scenario for each document
- GREET methodology included in all pathways
- Input values have been changed for CA where appropriate
  - crude recovery efficiency
  - electricity mix
  - etc.
- Model does NOT include vehicle adjustment factor

CA-GREET 1.7 v98

General Notes about the Pathways (2)

- Modifications made to input values could have led to values being different from AB 1007 or UC Reports
- All values preliminary at this point
- Stakeholders encouraged to review and comment

CA-GREET 1.7 v98

Methodology of Energy and GHG Emissions Calculations

CA-GREET 1.7 v98

Energy Calculation Methodology

- Fuel Shares: Amount of energy resource consumed during the production, transportation, processing, and distribution of a transportation fuel
- Btu/mmBtu: Calculated Btu of energy needed to produce one million Btu of the indicated fuel output
- Numbers still being refined

CA-GREET 1.7 v98

GHG Emissions Calculation Methodology

- GREET includes: CO_2,CO, VOC, CH_4, and N_2O
  - CO, VOC converted to CO_2 in a short time in atmosphere
  - CH_4, N_2O are IPCC recognized GHG gases
- Carbon Intensity (CI) reported in gCO_2e/MJ
- GHG calculated in g/mile and converted to gCO_2e/MJ
  - For CO_2,CO, VOC: based on carbon content in the fuel and its density.
  - For CH_4, and N_2O: based on California Climate Action Registry (CCAR) emission factors (g/mile)

Land Use

- Land Use (direct and indirect) not included

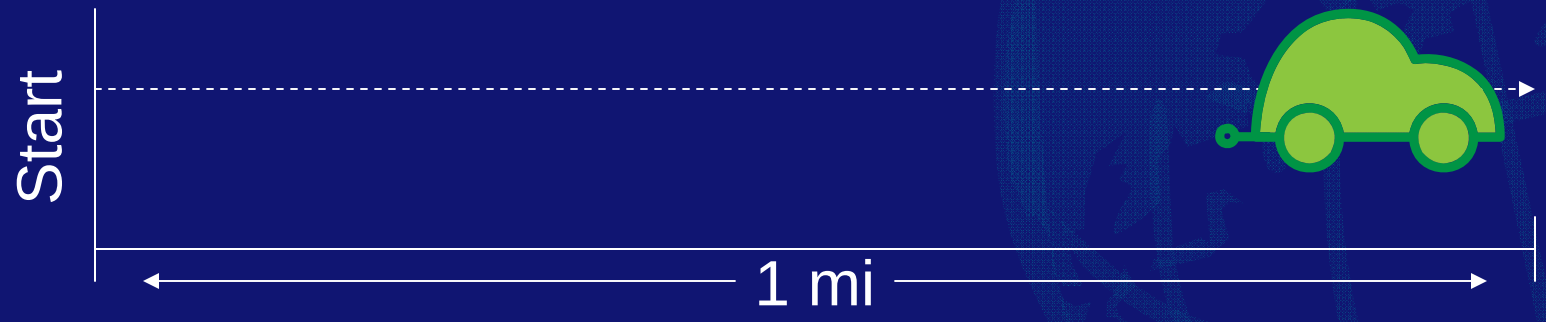
Vehicle Adjustment Factor

- LCFS will include a vehicle adjustment factor
- Recognize that some vehicles and fuel have better efficiencies
- Still determining appropriate adjustment factors

Vehicle Adjustment Factor

Amount of energy (MJ) used per mile

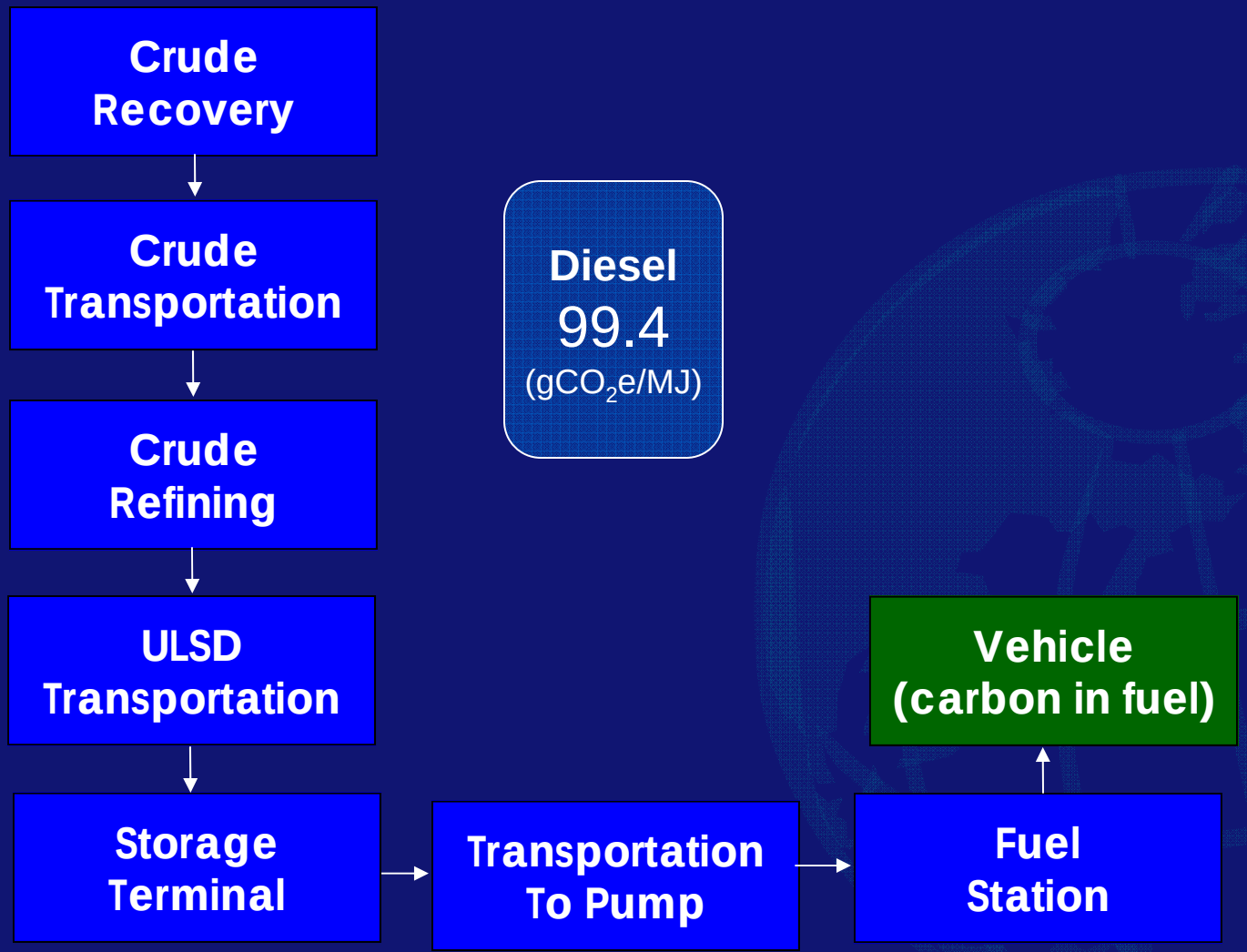
Amount of energy (MJ) a standard gasoline car uses per mile



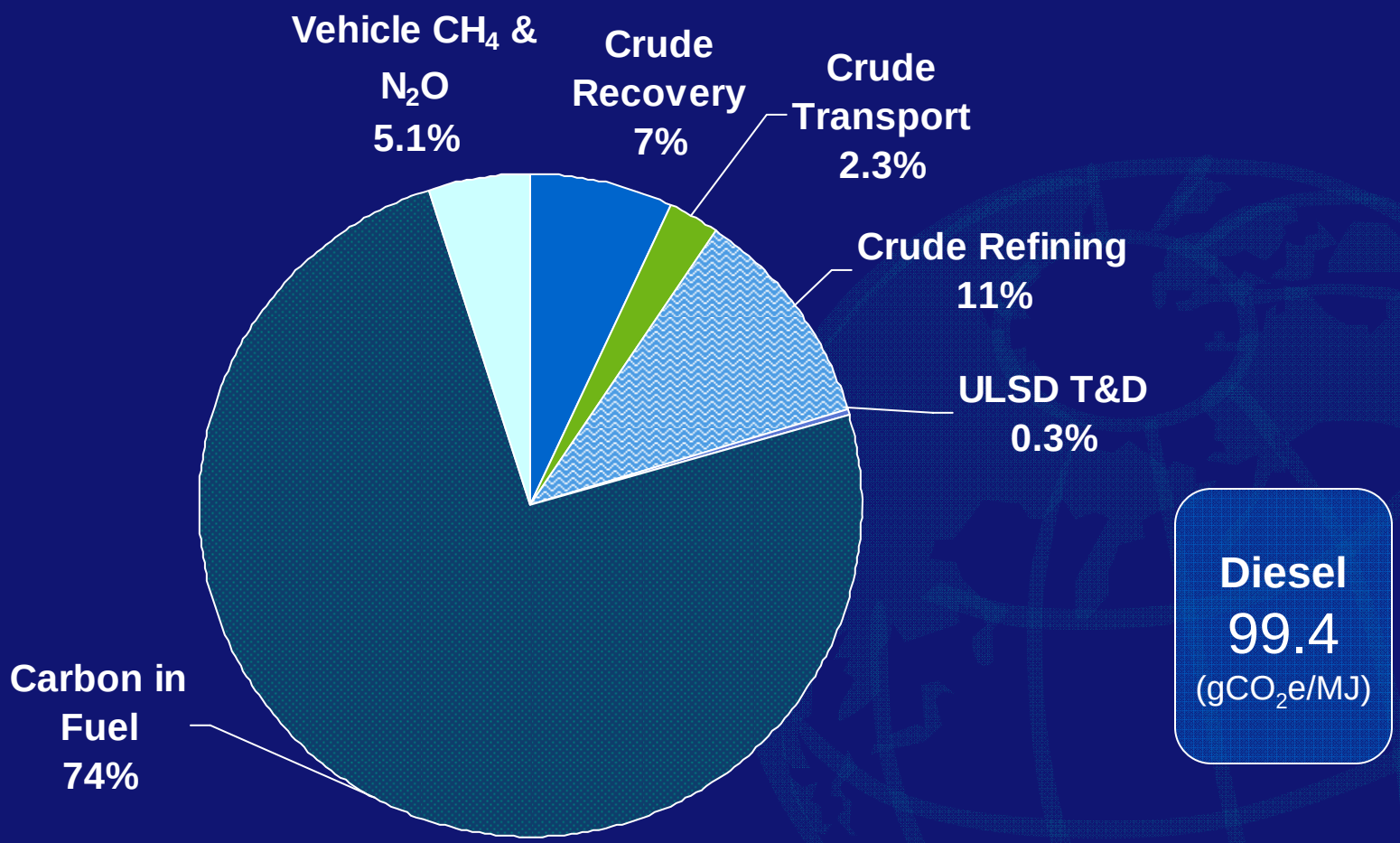
Fuel Pathways

CA-GREET 1.7 v98

Overview of ULSD Pathway



ULSD
%GHG Emission Contributions



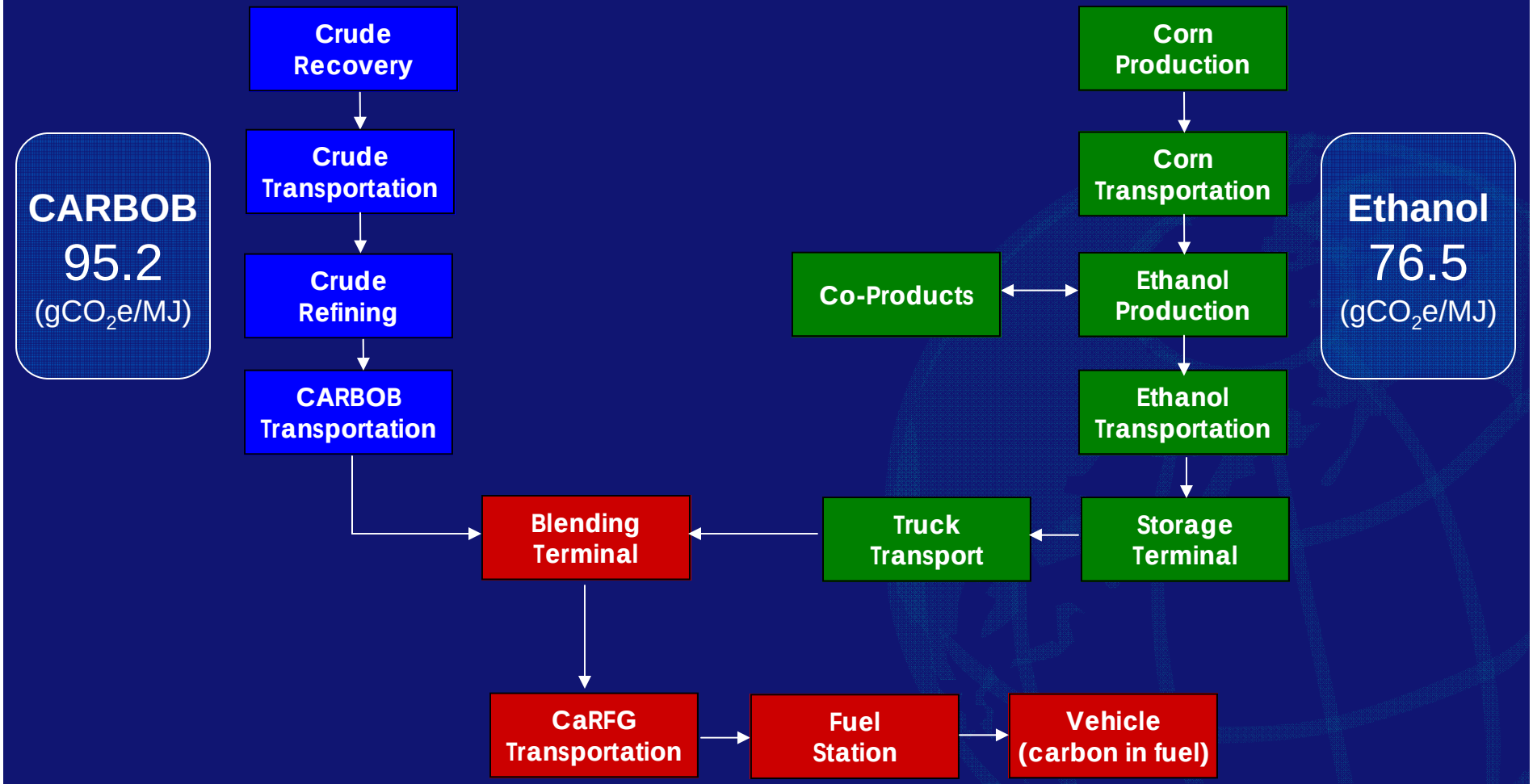
CA-GREET 1.7 v98

General Notes about ULSD

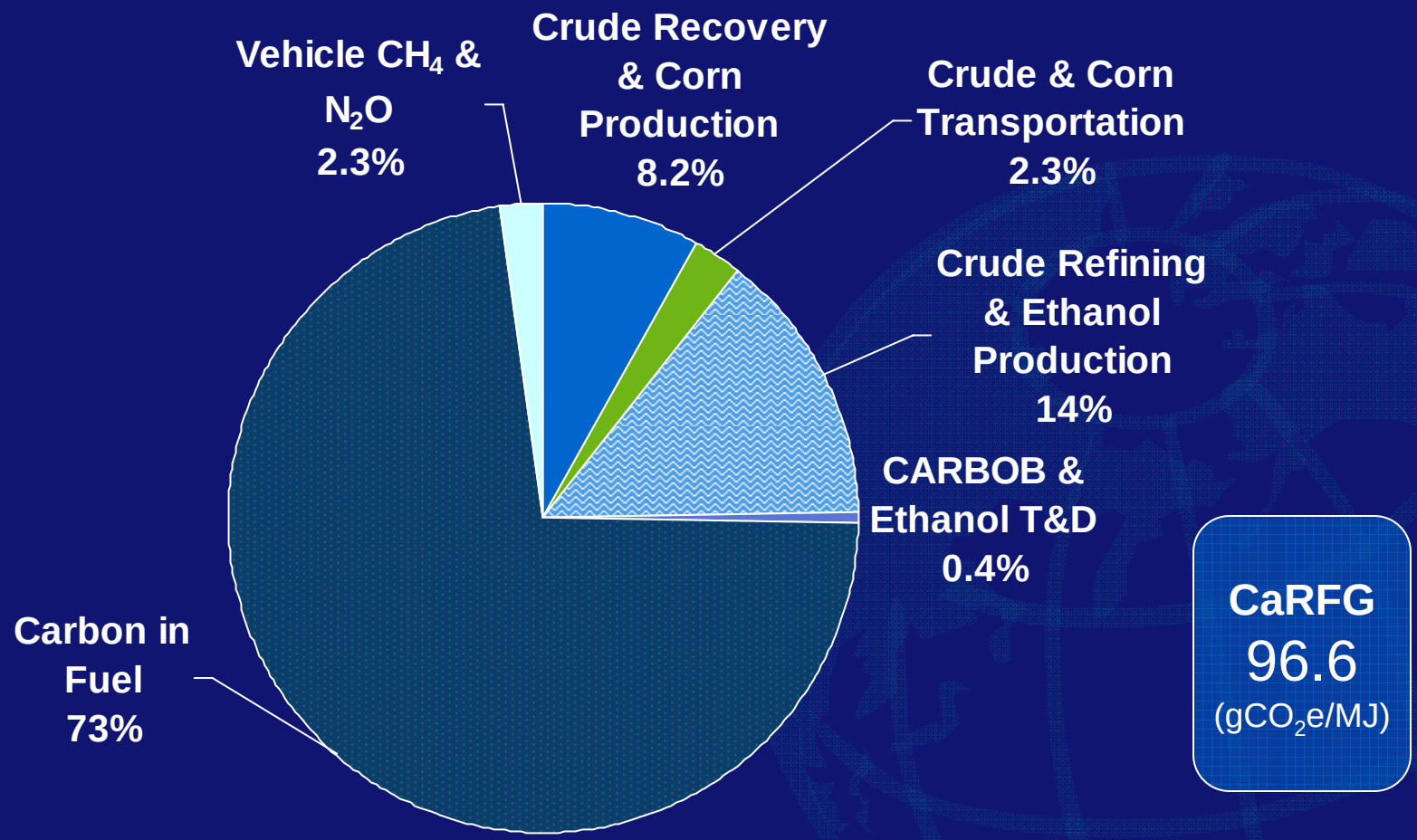
- Considers CA average crude mix refined in CA
- UC reported values of CI of 91 but here CI ~99
- Tailpipe N_2O and CH_4 included
- Crude recovery includes CA heavy crude recovery
- Preliminary at this point
- To illustrate GREET embedded methodology
- Stakeholders encouraged to review and comment

CA-GREET 1.7 v98

Overview for CaRFG Pathway



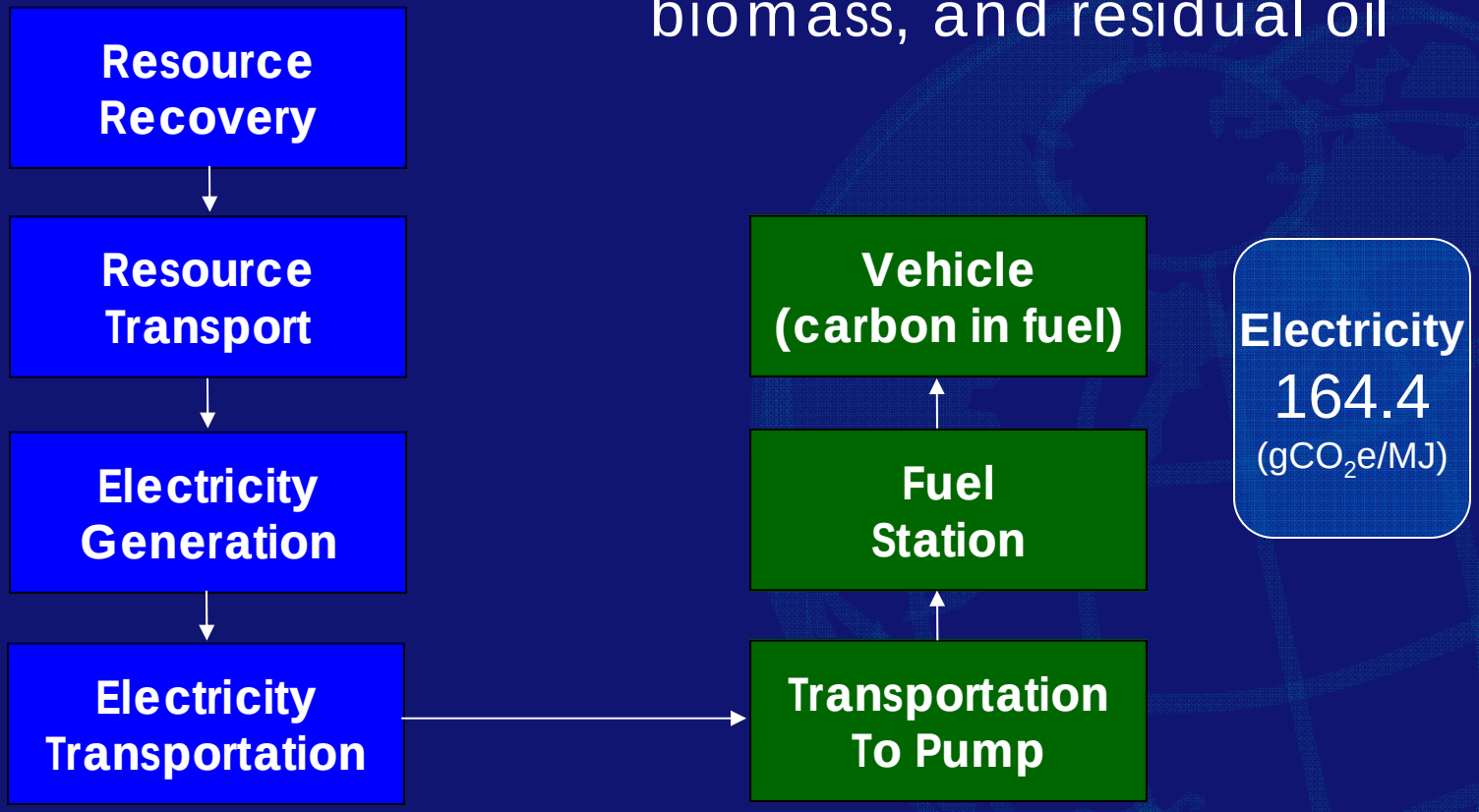
CaRFG
%GHG Emission Contributions



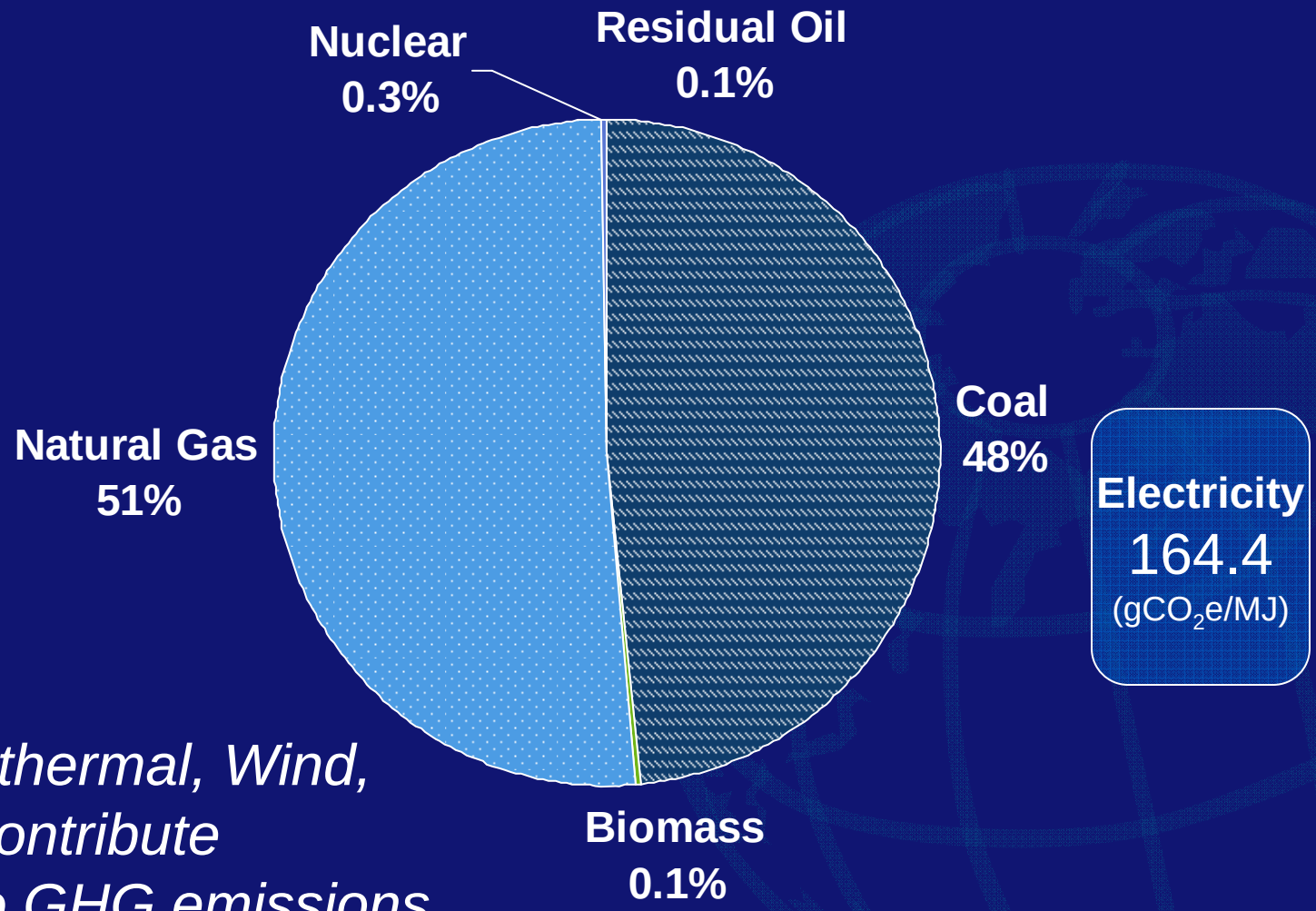
CA-GREET 1.7 v98

Overview for Electricity Pathway

Resources include: natural gas, coal, other (includes wind, hydro, etc.) uranium, biomass, and residual oil



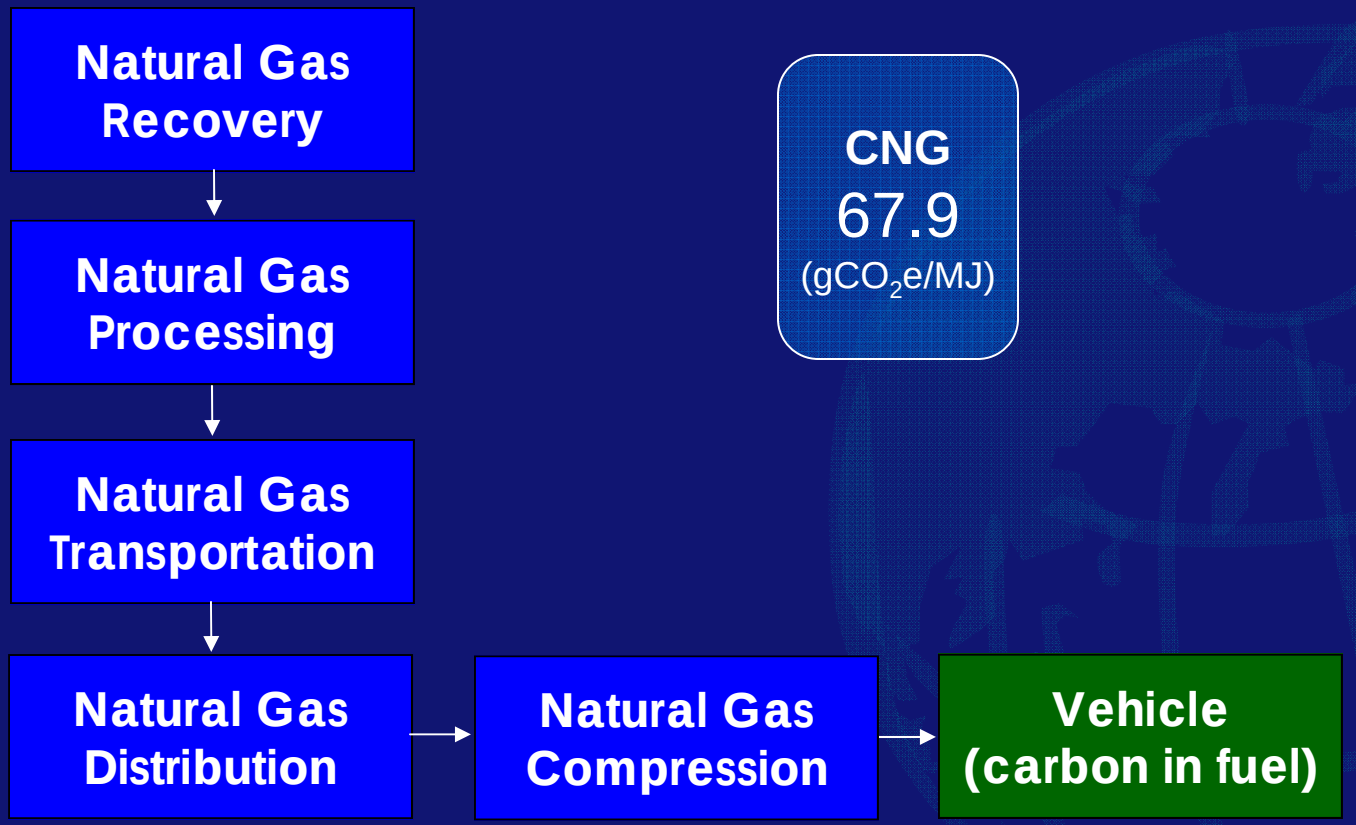
Electricity Production %GHG Emission Contributions



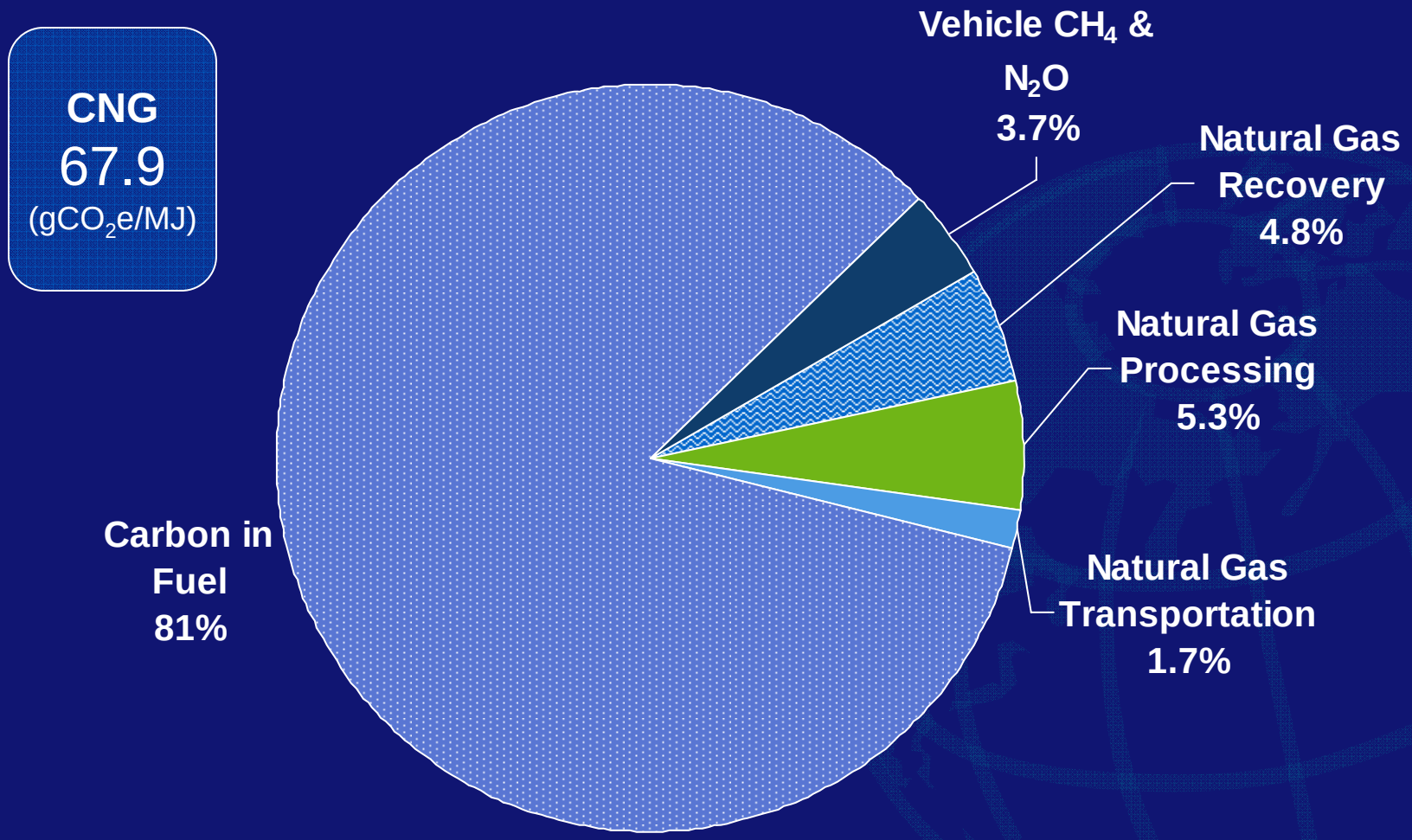
Hydro, Geothermal, Wind, and Solar contribute negligibly to GHG emissions

CA-GREET 1.7 v98

Overview for CNG



CNG
%GHG Emission Contributions



Future Pathways

- Biodiesel
- LNG
- Cellulosic Ethanol
- Hydrogen
- Renewable Diesel
- Propane
- Bio-methane
- Coal-to-Liquid
- Gas-to-Liquid
- Oil Sands

Others?

CA-GREET 1.7 v98

Future Work on Pathways

- Review stakeholder comments and update if necessary
- Incorporate aspects of GREET 1.8b into CA version
- Provide updated CA-GREET model
- Review current input values and update if appropriate
- Detail additional pathways as needed

Tentative Working Group Meeting

- Next Lifecycle Analysis Working Group Meeting

Proposed: June 16, 2008

See LCFS website for details